“DESIGN OF A CENTRALIZED FIRE STATION FOR EFFICIENT FIREFIGHTING OPERATIONS, RESCUE, AND EMERGENCY RESPONSE AT MOTORPOOL, BARANGAY SAPANG PALAY PROPER, CITY OF SAN JOSE DEL MONTE, BULACAN”

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Bachelor of Science in Civil Engineering

Major in Construction Engineering

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RECOMMENDATION

This is to certify that this research, titled "DESIGN OF A CENTRALIZED FIRE STATION FOR EFFICIENT FIREFIGHTING OPERATIONS, RESCUE AND EMERGENCY RESPONSE AT MOTORPOOL, BARANGAY SAPANG PALAY PROPER, CITY OF SAN JOSE DEL MONTE CITY", prepared and submitted by Guian Abigail DP. Santos, John Marwin D. Taganna, Rheyven B. Juan, and Sophia Banico have been examined and PASSED the PRE-ORAL DEFENSE.

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We hereby certify that this thesis is our own work and that to the best of our knowledge and belief, it contains no material previously written or published by another person or organization nor any material which has been accepted for award of any other degree or diploma from a university or institution of higher learning, except where due acknowledgement is made thereof.

Furthermore, we declare that the intellectual content of this thesis is the product of our work, although we have received assistance from others on the manner of organization, presentation, language, and style.

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CHAPTER 1

The Problem and its Background

This chapter presents the study overview, including the introduction, background of the study, theoretical framework, statement of the problem, hypotheses, scope and limitations of the study, significance of the study, and definition of terms.

Background of the Study

Rapid urban growth, rising populations, and increased business activity in every municipality in the Philippines are leading to more frequent and complex responses to fires, road accidents, and other emergencies that require immediate and effective action. The City of San Jose del Monte is experiencing changes in land use, higher traffic, and a lack of emergency facilities. Some existing facilities are not well-maintained. This situation shows a clear need for better solutions for local emergency operations and responses.

Fire incidents are one of the significant threats to lives, properties, and overall safety of communities. The efficiency of firefighting operations and emergency responses also depends on equipment, the availability of adequate facilities, and a well-coordinated fire station system. However, nowadays there are many outdated facilities and long response times, which compromise public safety

and disaster management. To tackle this issue, the researcher will create a design of a centralized fire station. This station will allow for an effective distribution of manpower, vehicles, and rescue equipment in one strategic location. It will enable quick deployment during emergencies. The design also encourages better coordination among firefighting teams and improves disaster preparedness measures. By centralizing operations, the fire department can make the most of its resources and reduce delays, which are crucial in life-threatening situations. “The primary objective of locating a fire station is to minimize response time, the interval between receiving a call and arriving at the incident site.” (Kobos & Ross, 2025)

Additionally, the design of a centralized fire station is not just about constructing a structure, but the design also talks about integrating functionality, efficiency, and community safety. Modern fire stations are composed of rescue equipment storage, must be equipped with training facilities, must have emergency medical response units, communication technologies, and more. The study of designing such facilities emphasizes the significance of establishing a hub that meets firefighting, rescue, and emergency demands. Therefore, providing a sustainable and long-term solution for safeguarding the community is essential.

Introduction

Because of its remarkable transformation from a resettlement area to a developing, economically independent community, the City of San Jose del Monte, Bulacan (CSJDM) has been recognized as "The Rising City." This fast development

is driven by its strategic location near Metro Manila, which offers excellent connectivity and attracts homebuyers and businesses that leads to experiencing rapid growth in its real estate, commercial, and social services sectors, spurred by new infrastructure, economic investment, and a growing, diverse population.

The growing population, increased commercial activity, and more traffic congestion have changed its urban landscape, turning lands into residential and commercial properties significantly. However, these changes also raise the risks of fire incidents and other emergencies from fire incidents and other emergencies from the large housing estates and closely located establishments. In this part of the city, fire stations are frequently outdated, and emergency facilities are limited. These conditions give a highlight for the need for better and more advanced emergency response infrastructure in the area.

Fire hazards are one of the biggest threats to public safety in CSJDM. The The Bureau of Fire Protection (BFP) reported that most fire incidents in the Philippines continue to be caused by faulty electrical wiring, overloading of outlets, and “octopus” connections, followed by open flames and LPG leaks (Philstar, 2025) Because residential buildings and businesses are so close to one another in densely populated, mixed-use urban areas like CSJDM, these hazards pose a threat (Durano, 2023; Lumina Homes, 2023). Despite the local government of CSJDM and the Bureau of Fire Protection launching programs in schools and barangays to improve fire response, issues still exist. These include poor response time, an outdated fire station, and a lack of strategic and modern planning (CSJDM LGU, 2024).

The Fire Code of the Philippines sets the rules for fire safety and the standards for creating and maintaining fire stations. However, the city's rapid growth has outstripped its emergency facilities. The 2006 fire incident in San Jose del Monte, which resulted in seven deaths, shows the dangers of inadequate facilities and late responses due to traffic congestion. Research in 2023 found that fire station locations significantly affect response effectiveness, and sub-optimal siting can lead to longer dispatch times and increased property damage." (Labita & Namoco, 2023)

Establishing a centralized fire station at CSJDM is vital to help with a wide range of natural and man-made disasters, including destructive fires, natural events like typhoons and earthquakes, and various emergencies such as medical, search and rescue, and hazardous materials incidents. A centralized fire station facility would allow for coordinated personnel, vehicles, and rescue equipment deployment, cutting down emergency response delays. Adding training facilities, medical response units, and modern communication systems, which are essential for today's fire safety operations and rescue, would provide comprehensive assistance for both man-made and natural disasters.

International frameworks increasingly highlight the critical role of centralized hubs, coordinated resources, and preparedness systems in reducing disaster risk and mitigating damages. (United Nations Office for Disaster Risk Reduction 2023). Strategic placement of fire stations using p-median and maximum covering models can significantly increase service coverage and reduce response times, according to studies on location analysis conducted at Cagayan de Oro

(Habibi et al., 2023). The said studies highlight the significance of integrating data-driven planning with real urban needs for disaster response.

The goal of this study is to plan and create a centralized fire station for CSJDM while keeping these factors in the forefront. This study aims to provide a long-term, feasible solution that complies with worldwide best practices and national fire code regulations, by integrating cutting-edge facilities, a realistic architecture, and effective coordination mechanisms, the proposed centralized fire station seeks to increase community resilience, save lives and optimal mitigation, and ensure that the city's growing population receives adequate assistance during emergencies.

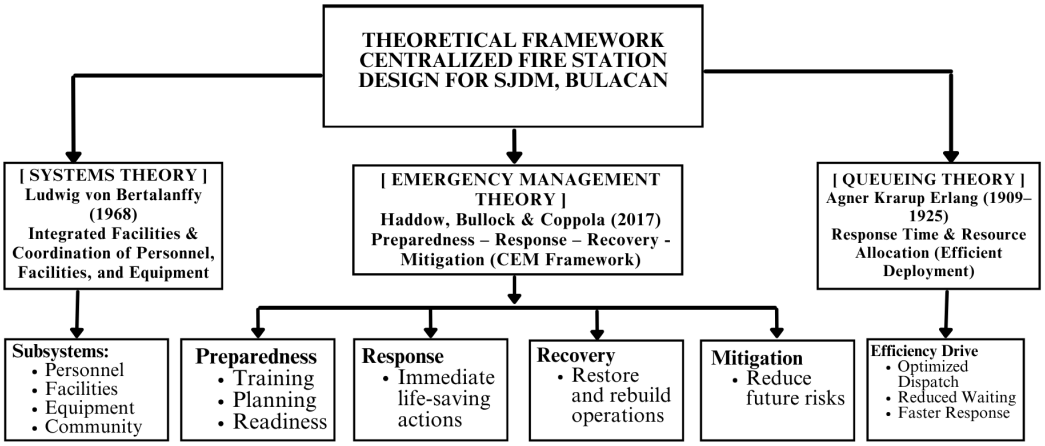
Establishing a centralized fire station at CSJDM is vital to help with a wide range of natural and man-made disasters, including destructive fires, natural events like typhoons and earthquakes, and various emergencies such as medical, search and rescue, and hazardous materials incidents. A centralized fire station facility would allow for coordinated personnel, vehicles, and rescue equipment deployment, cutting down emergency response delays. Adding training facilities, medical response units, and modern communication systems, which are essential for today’s fire safety operations and rescue, would provide comprehensive assistance for both man-made and natural disasters.

To lower risks and mitigate the effects of disasters, international frameworks, such as the United Nations Disaster Readiness Model, emphasize the necessity of central hubs, resource coordination, and readiness (PreventionWeb, 2009). Studies on location analysis in other Philippine cities, like Cagayan de Oro, show that

placing fire stations strategically based on P-median and maximal covering models can greatly boost service coverage and cut response times (Habibi et al., 2023). These studies give highlight to the significance of integrating data-driven planning with real urban needs for disaster response.

The goal of this study is to plan and create a centralized fire station for CSJDM while keeping these factors in the forefront. This study aims to provide a long-term, feasible solution that complies with worldwide best practices and national fire safety regulations. By integrating planned facilities, a realistic architecture, and effective coordination mechanisms, the proposed centralized fire station seeks to increase community resilience, save lives and optimal mitigation, and ensure that the city's growing population receives adequate assistance during emergencies.

Theoretical Framework



According to Ludwig von Bertalanffy (1968), Systems Theory emphasizes the need to integrate facilities and coordinate personnel, equipment, and the community as connected parts. This approach suggests that effective fire station design should view these elements as a unified system working together for greater efficiency. When personnel, facilities, equipment, and the community work together systematically, the fire station is better prepared to handle fire emergencies effectively. Haddow, Bullock, and Coppola (2017) discussed in Emergency Management Theory, particularly the Comprehensive Emergency Management (CEM) framework, that preparedness, response, and recovery are key elements in disaster management. Preparedness involves well-planned barracks, simulation facilities, and the right equipment. Response requires vehicle bays, and strategies for quick deployment. Recovery focuses on medical and rescue facilities and the support needed after disasters. These phases work together to ensure the fire station can reduce risks, respond quickly to emergencies, and provide necessary assistance during operations. Additionally, Agner Krarup Erlang (1909-1925) introduced Queueing Theory. This theory highlights the importance of response time and efficient resource use. Applying it to fire station operations shows the need for better dispatch systems, shorter waiting times, and faster emergency responses.These theories form the foundation for the centralized fire station design in the City of San Jose del Monte, Bulacan, aiming to enhance community safety, improve response efficiency, and strengthen disaster resilience.

Figure 1. *Theoretical Framework*

Conceptual Framework

INPUT	PROCESS	OUTPUT
1. Respondents' Demographic and Operational Profile, including: ● Gender ● Field of involvement (BFP personnel, rescuers, OJTs, related professions) ● Place of assignment or training ● Type of emergencies frequently responded to ● Perception of current station adequacy ● Identified Facility **2. Requirements for a centralized fire station in terms of:** ● Drone operation and monitoring area ● Modern vehicle bays for fire trucks and rescue units ● Command and control center with advanced	**1. Data Collection** ● Distribution of survey questionnaires to BFP personnel, OJTs, rescuers, and related respondents. ● Key informant interviews with Fire Marshals, Station Commanders, and emergency operations officers. ● Observation and site visits to existing fire stations for validation of spatial and facility conditions. **2. Data Analysis** ● Analysis of survey responses using frequency, percentage, and weighted mean to determine the importance of facilities. ● Thematic analysis of interview responses	**1. Centralized Fire Station Implementation** ● A fully established centralized fire station aligned with empirical data. ● Reflects operational needs and complies with regulatory standards. **2. Enhanced Operational Readiness and Response Capability** ● Improved dispatch efficiency and reduced response times. Thematic analysis of interview responses to identify operational challenges and space requirements. ● More efficient mobilization and deployment of vehicles. ● Better utilization of training programs for personnel.

communication systems ● Training and simulation facilities ● Medical and rescue support rooms ● Barracks and living quarters for firefighters and rescuers ● Additional support facilities (e.g., storage rooms, workshops, offices) **3. Reference Standards and Guidelines such as:** ● National Building Code of the Philippines (NBCP) ● National Fire Code (RA 9514) ● Bureau of Fire Protection Modernization Act (RA 11589) ● International design standards for fire stations and emergency facilities	to identify operational challenges and space requirements. ● Comparison of findings with building and fire protection standards. **3. Design Development** ● Formulation of a space program based on identified facility needs and personnel requirements. ● Preparation of a site development plan, floor plan, architectural layout, and structural concept. ● Integration of modern firefighting technologies and accessibility features.	**3. Sustainable Operational Feedback System** ● Continuous use of operational data to refine station design. ● Ongoing improvement of processes and workflows. ● Training programs regularly updated based on real-world performance.

Figure 2. *Conceptual Framework*

Statement of the Problem

The City of San Jose del Monte, Bulacan, is one of the fastest-growing urban centers in Central Luzon. Its rapid urbanization, population growth, and increased commercial activities have brought greater risks of fire incidents and emergencies. However, the current fire protection and emergency response facilities in the city remain limited and are often challenged by accessibility, manpower distribution, and outdated infrastructure. These constraints may hinder the Bureau of Fire Protection (BFP) in delivering quick and effective services, especially in highly populated areas. At present, the BFP personnel operate from a rented office space that also functions as a temporary parking area for their fire trucks and service vehicles.

To address these challenges, this study aims to design a Centralized Fire Station at Motorpool, Barangay Sapang Palay Proper, San Jose del Monte City, Bulacan, equipped with modern facilities such as vehicle bays, barracks, command centers, and recovery units. The project seeks to improve the operational capacity of the BFP, enhance public safety, and strengthen the city's resilience against fire hazards and other emergencies.

Specifically, this study aims to answer the following questions:

1. What are the present status and challenges faced by the fire stations currently operating in the City of San Jose del Monte, Bulacan?

2. What is the demographic profile of the respondents in terms of:

2.1 Gender

2.2 Field of Involvement

2.3 Place of Assignment or Training

2.4 Type of Emergencies Most Frequently Responded To

3. How do the needs and preferences of the Bureau of Fire Protection (BFP) San Jose del Monte influence the design of a centralized fire station in terms of:

3.1 Firefighting Facilities (e.g., vehicle bays, equipment storage)

3.2 Rescue and Medical Facilities (e.g., recovery units, medical stations)

3.3 Emergency Support Facilities (e.g., barracks, command center)

4. How spatial layout and design considerations can be developed based on the operational and functional needs identified through surveys and interviews in terms of:

4.1 Space allocation and distribution

4.2 Facility zoning and functional relationships

4.3 Space allocation for vehicles, personnel, and equipment

4.4 Circulation flow and accessibility within the facility

Objectives of the study

The main goal of this study is to design and assess a centralized fire station at Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte, Bulacan. It will focus on modern facilities that can improve firefighting, rescue, and emergency response operations. This project aims to strengthen the Bureau of Fire Protection's (BFP) ability to operate, increase public safety, and address the city's growing needs from rapid urban growth.

Specifically, the objectives of the study are the following:

1. To assess the current status and challenges of fire stations in San Jose del Monte, Bulacan, to identify gaps in facilities and space allocation that affect firefighting and rescue efficiency.
2. To examine the respondents' gender, field of involvement, assignment, and common emergencies they handle, providing insights into how these factors influence their performance and training needs, which are essential for designing facilities that effectively support operational functions and personnel well-being.
3. To evaluate the needs and preferences of the Bureau of Fire Protection in San Jose del Monte regarding the design of a centralized fire station, focusing on firefighting, rescue and medical, and emergency support facilities, in order to ensure that the proposed design aligns with operational requirements and enhances overall emergency response efficiency.

4. To identify the spatial and structural design considerations based on the operational and functional needs gathered from surveys and interviews, including building layout, facility zoning, space allocation, and circulation flow, to create a practical and well-organized fire station that supports efficient emergency response.

Hypothesis

Ha: There is a significant relationship between the inclusion of modern and properly planned facilities in a centralized fire station and the improvement of firefighting efficiency, rescue operations, and emergency response in the City of San Jose del Monte, Bulacan.

Ho: There is no significant relationship between the inclusion of modern and properly planned facilities in a centralized fire station and the improvement of firefighting efficiency, rescue operations, and emergency response in the City of San Jose del Monte, Bulacan.

Significance Of the Study

This study might contribute to the safety and resilience of the City of San Jose del Monte by emphasizing the advantages of setting up a central fire station with modern facilities.

Its conclusions might affect several fields and populations, such as:

Community: This study provides direct support to the people of San Jose del Monte

by ensuring quicker emergency response and better public safety. The centralized fire station will safeguard employment, property, and people from fires and disasters with features like recovery units and barracks.

Department of the Interior and Local Government (DILG): This study enhances the capacity of the DILG by addressing issues like old and outdated infrastructure, poor accessibility, and a less place for personnel to take rest. The organization receives modern amenities that enhance disaster response, rescue operations, and firefighting.

Local Government: The results of this study are intended to be a useful guide for the City Government of San Jose del Monte in enhancing urban planning and catastrophe preparedness. It offers a starting point for funding safety infrastructure that satisfies the demands of its expanding metropolitan populace.

Urban Development and Construction Sector: This research highlights new approaches for designing fire stations. It emphasizes the inclusion of modern features such as command centers and medical stations. This study could serve as a guide for future infrastructure projects that aim to improve city resilience and public safety.

Academic Field: This study helps us understand the connection between civil engineering, architecture, and disaster management. It offers a guide for designing community safety facilities and serves as reference material for students, teachers, and researchers.

Future Researchers: This study lays the foundation for upcoming research. It promotes investigation into traditional designs and centralized fire stations. It also provides a chance to explore new technology in public safety infrastructure and sustainable building practice.

Scope and Limitation

This study focuses on the design of a centralized fire station in the City of San Jose del Monte, Bulacan, specifically at Motorpool, Barangay Sapang Palay Proper. In order to plan and render a modernized fire station, the scope includes creating a site development plan, floor plan, and 3D architectural layout using Autocad and SketchUp. This will emphasize the integration of facilities like vehicle bays, barracks, command and control center, drone operation area, medical support units, and training facilities. To improve citywide emergency response, rescue operations, and firefighting operations, the design places a strong emphasis on efficiency, functionality, and accessibility.

In addition to the design, the researchers conducted surveys and interviews with selected Bureau of Fire Protection (BFP) personnel to identify the necessary facilities and community requirements. Baseline data was established by collecting profiles based on gender, place of assignment, and field of involvement. In order to match the suggested design with operating standards and emergency requirements, data provided by BFP staff was taken into consideration. This study is being conducted by researchers at La Concepcion College Inc. and the focus area where

they will collect data for the design and gathering information from the CSJDM BFP office will only come from San Jose del Mon Bulacan, specifically at Motorpool, Barangay Sapang Palay Proper.

Although the design emphasizes modern features, these facilities were not the subject of any structural investigation or physical modeling. This research is limited to the design and conceptual stages. The scope of this research does not include the actual building, acquisition of materials, and practical execution of the centralized fire station.

Comprehensive analyses of financial funding models, post-construction running expenses, and long-term maintenance are not included in this research. The only emergency situations taken into account are fire occurrences, rescue missions, and local natural calamities like typhoons and earthquakes. The scope did not include incidents connected to terrorism or other types of events such as pandemics. The study guarantees a targeted evaluation of how a centralized fire station design might enhance public safety, emergency response, and resource coordination in San Jose del Monte City by establishing these parameters.

Definition Of Terms

Architectural Plan: A detailed drawing that shows the design, layout, and structure of a building, serving as a guide for construction.

AutoCAD: A computer-aided design (CAD) software used by architects and engineers to create precise 2D and 3D drawings of structures and system.

BFP Firefighter: A very well-trained person with sufficient knowledge about fire prevention, suppression, and emergency response.

Bureau of Fire Protection (BFP): A government agency in the Philippines responsible for fire prevention, fire suppression, and implementing national fire safety policies.

Centralized: The act of concentrating authority, resources, or personnel in a single main location or point, allowing easier management, coordination, and quicker response.

Emergency: An unexpected event that poses risks to life, property, or the environment and requires urgent action.

Feasible: Refers to a plan or design that is practical, workable, and possible to implement.

Fire: A chemical reaction that produces heat and light, often destructive, that can cause harm to life and property.

Fire Code of the Philippines: A law that sets standards, rules, and regulations for fire safety, prevention, and maintenance of fire stations.

Fire Hazard: Any condition, object, or action that increases the likelihood of a

fire outbreak, endangering people, property, and the environment.

Fire Station: A facility where fire engines, equipment, and firefighters are housed, trained, and dispatched for emergency response.

Floor Plan: A scaled drawing that shows the arrangement of rooms, spaces, and elements in a building from a top view.

Hazard: Any source or situation that has the potential to cause harm to people, property, or the environment.

Response: Immediate action taken to manage and reduce the impact of emergencies or dangerous situations.

SketchUp: A 3D modeling software used to create, visualize, and present architectural and design projects in a simple and interactive way.

Strategic Location: An area chosen to ensure rapid emergency response, maximum coverage, and access to high-risk or critical zones.

3D Design: A digital or physical representation of a structure in three dimensions, providing a realistic view of the project.

CHAPTER 2

Review of Related Literature

A review of relevant studies and literature is presented in this chapter, following a comprehensive search by both domestic and international researchers. They facilitate familiarization with pertinent and comparable information to the current investigation.

Foreign Literature

According to Shahparvari et al. (2020), the fire emergency quick response is essential because any delay can result in serious injuries, loss of lives, or even death. As the cities grow and urban areas become more complex, it is challenging to respond quickly. The researchers focus on Melbourne, Australia, analyzing the current distribution of fire stations using advanced location-allocation models with Geographic Information System (GIS). The study found that some neighborhoods experience longer response times exposing coverage gaps for fire services. By suggesting optimal new locations and recommending adjustments to existing stations, the study aims to improve coverage from 81% to 95% within a critical five-minute response window. This study will not only deal with faster firefighting

efforts but also with better protection for residents and to their properties. The study highlights the power of using spatial data and modeling tools to guide smart decision-making in emergency planning. In general, it highlights the importance of strategic fire station placement to save lives and enhance urban safety.

Fire safety in rapidly urbanizing cities like those in China is becoming a critical concern, with traditional fire station planning methods proving increasingly inadequate. According to Chen et al. (2025), in all efforts for improving emergency response infrastructure, high-density development and uneven resource distribution have created large service gaps, putting human lives and property at risk. The study highlights that the existing fire station siting standards, such as a 5-minute response radius and fixed service areas, often ignore the varying degrees of fire risk found across different urban zones, such as Industrial, commercial, residential, and institutional areas. It is intended that the location of the fire station is a big factor when it comes to response in a standard time.

According to Renkas et al. (2022), optimization of fire station locations to increase the efficiency of firefighting in natural ecosystems. This highlights the importance of locating the fire station specifically in natural ecosystems. Optimizing fire stations can ensure the protection of human lives and prevent the spread of fire in natural ecosystems and rural areas. Lack of fire stations and poorly located fire stations can be a threat to life and property. This is one of the reasons why fire stations should be increased or centralized to meet the standard

emergency response time.

According to Dey et al. (2021), it shows the delicate balance between the consolidating fire stations for efficient emergency response across the complex urban landscape. It emphasizes the matter of how the fire stations are placed relative to population density, road networks, traffic flow, and emergency demand because simply centralizing services won't automatically improve outcomes. The models show that a thoughtful consolidation, where some smaller fire stations are merged and a few robust central hubs are strategically located, can reduce duplicative coverage and demand patterns. The article says it's about the better-location, better-connected ones, and not because of fewer stations.

According to KC et al. (2024), fire protection in Kathmandu is not merely a planning issue but a vital public safety concern. The study observes that some areas take more than ten minutes for responses because population and infrastructure are increasing rapidly. From 2019 to 2023, using ward-level, only 30 percent of buildings in Kathmandu are reachable. Their suitability analysis combines variables like fire rate, return time, street connectivity, and population to score wards for potential new station placement, then refines possible sites through overlaying land use and river proximity. This study found that peripheral wards in particularly 31 and 32, are prime candidates for new stations to reduce underserved zones. More than numbers, the authors connect fire risk to social vulnerability. Areas with many renters, low schooling, and LPG usage show stronger fire patterns, urging equitable planning. Their work urges that locating

fire stations is more than geometry and it's about reducing human vulnerability in dense, fast-changing cities. Finally, it hopes their framework can guide policy in similar developing cities, where sparse data and high stakes make smart design essential.

Local Literature

According to the Bureau of Fire Protection (2022), fire station placement plays a critical role in minimizing dispatch delays and reducing both loss of life and property damage (as noted by Abalos 2022). This highlights that response time is the most important factor in emergency services like fire stations. The longer it takes for a fire response team to arrive, the higher the risk of fatalities and property damage. Therefore, fire station sites and routes must be chosen carefully to ensure fast and efficient operations.

The Commission on Audit (2024) found that as of end-2023, 146 municipalities still lacked active fire stations or adequate fire trucks, highlighting that many fire-protection hubs remain sub-optimally located and under-resourced for effective emergency response. This gap persisted in subsequent years, with unmet performance targets reflected in the BFP's quarterly operational reports from 2018 to 2023 (Department of the Interior and Local Government – Bureau of Fire Protection, 2018–2023).

The passage of the BFP Modernization Act (Republic Act 11589, 2021) further reinforced the importance of upgrading fire stations nationwide. This law

mandates capital enhancements for BFP facilities, equipment, and personnel, intending to reduce response times and ensure operational efficiency across all Local Government Units (LGUs). By 2025, about 1,484 LGUs had BFP stations, though several remained pending for full operational status. In Davao Region, for instance, the BFP has set a seven-minute response time benchmark, with barangay-level substations being planned to avoid service gaps. However, infrastructure limitations remain a challenge, as seen in Dumaguete City, where the fire chief (2024) stressed the need for more fire hydrants in high-risk areas to complement station response.

Recent studies have focused on improving fire station placement using facility location modeling. Subteniente and Gomez (2024) applied models such as the Set Covering Location Problem (SCLP) and Maximal Coverage to recommend expansion sites for fire station infrastructure in Metro Manila, based on demand and incidence data. From a technical perspective, optimization methods like the Maximum Coverage Location Problem (MCLP) are useful for identifying ideal station locations. Atta et al. (2021) and Hamed et al. (2023) demonstrated applications of MCLP in urban emergency services, highlighting its potential to guide Philippine station placement. These models provide structured ways to evaluate high-risk versus low-risk locations, ensuring resource allocation is aligned with disaster preparedness and efficient coverage.

In local practice, GIS-based facility location modeling has been used to assess underserved areas and optimize station siting in highly urbanized areas.

Cruz, Ong, and Peralta (2022) applied a GIS-based multi-criteria analysis in Quezon City to map service areas of existing fire stations, revealing that poor coverage and road network limitations extended response times. Their study integrated the Analytic Hierarchy Process (AHP) with GIS to evaluate population density, hazardous land uses, road proximity, and distance to stations, exposing service gaps caused by network and siting limitations. Applying these GIS-based approaches to San Jose del Monte would provide an evidence-based strategy for siting a centralized fire station that meets the five-to-seven-minute response standard.

Improved incident reporting, mapping, and dispatch can also cut down delays in identifying and routing to fire sites, according to local technology initiatives. The creation of the Tabang fire emergency response application (Central Philippine University, 2022) serves as an example of how dispatch procedures may incorporate real-time situational data and GPS-enabled citizen reporting to facilitate quicker response. Designing a centralized station with a functional communications/ICT hub improves situational awareness for workers and controllers and allows for compatibility with such applications (Gubat, Lam, & Rabanes, 2022).

Foreign Studies

According to Moore (2023) in assessing fire station response and coverage ability in a Pennsylvania Town, there was a gap in fire station response times in a Pennsylvania township. Stations are staffed by volunteers, which creates problems with coverage and timely responses. As stated by Anderson (2021), it confronts the growing disconnect between the evolving needs of communities and the aging infrastructure and outdated models used in the fire volunteer services. As volunteerism continues to decline across the U.S., the one studied by many fire departments struggles with the old facilities, insufficient staffing, and resistance to change. The study sheds light on how some fire personnel cling to tradition or rely on ineffective planning methods, even when response times fall short of the NFPA's (National Fire Protection Association) “nine-minute, 90% of the time” standard. Anderson notes that while some firefighters are reluctant to consider relocation or a new station, the data shows that existing stations are poorly placed, leaving gaps in coverage and slowing response times. The research identifies critical spatial and operational gaps in the current system through a need-based assessment. The study argues that the fire service must evolve when it comes to realigning its resources with the realities of modern growth and risk. The Study highlights the value of data-driven analysis in justifying the siting of new fire stations and improving emergency coverage. Overall, fire departments can support not only public safety but also long-term community development and economic stability. Anderson’s work

humanizes fire service planning by framing it as a vital part of improving residents' quality of life.

As stated by Han et al. (2021), this study addresses the growing challenges faced by some urban areas, as rapid city expansion and increasing fire incidents put lives, property, and overall safety at risk. The study points out how critical the spatial arrangement of fire stations is to effective firefighting but points out that previous research often overlooks key issues like the randomness of fire outbreaks and traffic delays, which significantly affect response times. Using an innovative approach, the authors combine a set cover location model with spatiotemporal big data to link actual fire outbreak points with real-time traffic conditions, ensuring emergency teams can reach incidents quickly. It focuses on Nanjing, China, and it analyzes extensive data from fire incidents between 2014 and 2018, traffic congestion data, and existing firefighting infrastructure to understand fire risk patterns and calculate risk scores. The study applied clustering and Monte Carlo simulations to generate realistic random fire scenarios. The study sets a five-minute time response and vehicle speeds on each road to calculate travel times across the area. The final results were fine-tuned according to city land use plans, which led to a dramatic improvement in fire service coverage, increasing it from 58% to 90%. By combining big data analytics with traffic dynamics, the approach goes beyond traditional models, creating a more precise and adaptable framework for emergency planning. In general, the study deals a valuable insight for urban planners to look for the enhancing of fire safety through data-driven, responsive infrastructure design. By

doing so, it contributes to improving public safety and resilience in fast-growing cities worldwide.

According to KhoshAmooz (2024), as the population grows, fire stations are in demand as essential emergency services, making the strategic placement of fire stations more critical than ever. The study, which focused on Tehran, addresses the pressing issue of limited service coverage and delays in emergency response due to inefficient fire station distribution. The distance from existing stations, proximity to main roads, high population density areas, gas and fuel stations, historical and cultural sites, green spaces, and evacuation zones are the key criteria of evaluating the new location of fire stations. Additionally, the 5-minute service range of existing fire stations was calculated and excluded from consideration to avoid overlap and redundancy. As a result, five underserved districts—Regions 14, 15, 16, 17, and 20—were identified as high-priority areas for future fire station development. The study not only points out the importance of multi-criteria decision-making in urban planning but also gives a replicable data-driven model for other cities experiencing the same scenario. It reflects the global recognition that fire safety must evolve with urban growth. The study aims to enhance public safety through smarter, more inclusive planning decisions.

In “A Composite Approach for Site Optimization of Fire Stations,” Badi et al. (2022) tackled that the biggest challenge is the dispersed location of fire stations, which slows down reaction time because it takes an hour for rescue personnel to reach the scene. This study highlights the model for determining the ideal location of

a fire station in Misurata. To solve this, the blend FUCOM-COCOSO approach, allowing both quantitative data and expert insight to steer the decision. They evaluate sites based on six criteria. The population density, distance to existing stations, proximity to industrial zones, closeness to main roads, residential and commercial densities, and discover that densely populated zones carry the greatest weight. Their results suggest the ideal fire station should be near industrial clusters yet within reach of heavy residential zones, reflecting the way emergencies don't wait for neatly drawn boundaries. Although they haven't integrated GIS path analysis, their method offers a practical, human-centered way for planners to think about fire station consolidation or expansion in rapidly changing urban landscapes.

According to He et al. (2024), urban fire station locations should evolve beyond the traditional "build in every built-up area" approach to one rooted in risk, demand, and geography. They present a case study of Shanghai in which they assess fire risk across over nineteen thousand spatial units, using indicators like population density, incident density, building volume, land-use type, GDP density, and spatial location to classify areas into four risk levels (A-extremely high, B-high, C-moderate, D-low). Leveraging tools such as the Baidu Map API for realistic travel times over road networks and Gurobi for solving optimization, they explore different fire station deployment scenarios (50, 100, 150, etc. stations). Their findings suggest that constructing around 150 well-located stations offers a balance where the marginal gains in response coverage taper off beyond that number, yet still significantly improve response times and cover areas more uniformly. Importantly,

this approach identifies inefficiencies in the existing distribution of Shanghai's 152 stations; many densely built-up areas have overlapping low-demand jurisdictions, while suburban areas suffer large, thinly-served zones. By introducing risk-based models and hierarchical response time standards depending on area classification, this study humanizes station planning: it's not just about distance but about where people live, how built the environment is, how often fires happen, and what realistic travel paths look like. For other rapidly expanding cities, this work shows how data-driven, nuanced centralization and deployment can lead to more equitable, faster emergency response, while avoiding over-serving some areas and under-serving others.

Local Studies

Republic Act 11589, also referred to as the Bureau of Fire Protection Modernization Act of 2021, has placed a strong emphasis on modernizing fire stations in the Philippines. It requires that facilities, equipment, and personnel be upgraded nationwide in order to improve operational efficiency and decrease response times (Republic Act No. 11589, 2021). Despite this, many local fire stations continue to face logistical and infrastructure issues that limit their ability to consistently meet the required five- to seven-minute response time, according to the Bureau of Fire Protection's CY-2023 Annual Narrative Accomplishment Report (Bureau of Fire Protection, 2024).

Scientific approaches to alleviate these inefficiencies have previously been

investigated in highly populated places. In Quezon City, for instance, Cruz, Ong, and Peralta (2022) mapped fire station service areas using a GIS-based Analytic Hierarchy Process (AHP) and discovered that inadequate siting and road network constraints led to delayed responses. The Set Covering and Maximal Coverage placement Problems are two examples of facility placement models that Subteniente and Gomez (2024) used to suggest the best locations for fire station expansions in Metro Manila. These studies show how mathematical and geographical optimization approaches may be applied to ensure that urban people have fair access to services.

The Dumaguete City Fire Department also emphasized the importance of coordinated planning between the fire station's location and its supporting infrastructure, along with addressing siting and coverage issues (Philippine News Agency, 2024). Additionally, the creation of local technological solutions, like the Tabang fire emergency response application in Iloilo, demonstrates how ICT may facilitate quicker reporting and dispatching by allowing public engagement using GPS (Gubat, Lam, & Rabanes, 2022).

For fire stations to be efficient and functional, structural planning is just as important as location and ICT integration. Standard amenities for city-level fire stations must contain apparatus bays with sufficient clearance, a communications room, dormitories, administrative offices, training areas, and rescue equipment storage, under the Bureau of Fire Protection's Planning and Design Guidelines (2023). In addition to using durable building materials that can endure natural

calamities and fire dangers, the structural arrangement must guarantee the prompt deployment of fire vehicles from apparatus bays to the main road. Additionally, fire stations are guaranteed to serve as both emergency hubs and secure working environments through the incorporation of support infrastructure, including water supply tanks, standby generators, and appropriate zoning between residential and operating areas (Bureau of Fire Protection, 2023). Together, these local studies and reports show that the proposed centralized fire station in San Jose del Monte needs to be planned with integrated ICT facilities, supporting water infrastructure, and modernization standards in addition to strategic siting and road access. Its structural plan should also include full facilities that comply with BFP guidelines, including training areas, dormitories, communications and control rooms, and apparatus bays, so that the station can fully support emergency response, firefighting, and rescue operations.

Synthesis of the Literature and Studies

The studies and research papers reviewed highlight that response time is the most critical measure of efficiency in firefighting and emergency response. Altogether, they underscore the importance of strategic fire station siting, infrastructure modernization, and ICT integration, while pointing out persistent challenges in the Philippines such as poor coverage, inadequate support facilities, and infrastructural limitations. These works collectively stress that efficient fire station design is not only a matter of physical location but also of systematic

planning, modern facilities, and technology adoption to meet the national benchmark of a five- to seven-minute response time.

Republic Act 9514, or the Philippine Comprehensive Fire Code, establishes that firefighters must respond within five to seven minutes. This mandate is supported by Republic Act 11589 (2021), the Bureau of Fire Protection Modernization Act, which emphasizes upgrading fire stations, equipment, and facilities to reduce delays (RA 9514, 2008; RA 11589, 2021). Audit and performance reports from 2023 show that numerous fire stations under the Bureau of Fire Protection (BFP) remain poorly located or inadequately resourced, undermining response efficiency and fulfillment of coverage targets." (BFP-1st Sem 2023 Narrative Accomplishment Report, 2024)

Subteniente and Gomez (2024) used Set Covering and Maximal Coverage models to identify optimal station expansion sites in Metro Manila, demonstrating the value of mathematical approaches in improving service coverage. Similarly, Cruz, Ong, and Peralta (2022) applied a GIS-based Analytic Hierarchy Process (AHP) in Quezon City, revealing that inadequate siting and road network issues directly extended response times. These findings suggest that San Jose del Monte, with its mix of dense urban zones and peripheral barangays, would benefit from similar evidence-based modeling to ensure equal coverage.

Local accounts further emphasize support infrastructure gaps, such as Dumaguete City's (2024) reported shortage of fire hydrants in high-risk areas, underscoring the need to integrate water supply and hydrant networks with fire

station planning. Meanwhile, the Tabang fire emergency response application (Central Philippine University, 2022) illustrates how ICT innovations—like real-time GPS reporting—can strengthen dispatch efficiency and community involvement in emergencies.

Globally, Shahparvari et al. (2020) applied location-allocation modeling in Melbourne, Australia, increasing coverage efficiency from 81% to 95% within a five-minute response window. Chen et al. (2025) identified how rigid siting standards in China often neglect urban fire risks, calling for dynamic planning based on land-use and population density. KC et al. (2024) in Kathmandu connected fire risk to social vulnerability, finding that underserved areas with renters, LPG dependence, and low education levels required priority interventions. Similarly, Han et al. (2021) in Nanjing combined traffic data, fire incident points, and spatiotemporal modeling, improving service coverage dramatically by aligning deployment with real traffic conditions.

In the U.S., Anderson (2021) and Moore (2023) critiqued outdated volunteer-based fire systems, noting that poorly located stations fail to meet NFPA standards, highlighting the need for data-driven planning and modern infrastructure. He et al. (2024) in Shanghai likewise showed that risk-based models and hierarchical response standards can minimize both underserved rural zones and overlapping low-demand jurisdictions in urban centers.

From a design standpoint, the BFP Planning and Design Guidelines (2023) emphasize that modern fire stations should include essential facilities such as

apparatus bays, dormitories, communication centers, training areas, and dedicated storage for rescue equipment. These provisions align with the CAAP and Fire Code IRR standards on aerodrome fire safety, highlighting the importance of integrating safety and operational efficiency in land-based firefighting systems (BFP, 2023; CAAP MOS).

Altogether, these studies indicate that the proposed centralized fire station at Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte must go beyond basic siting. It should integrate GIS-based planning tools to ensure equitable coverage, adopt modern ICT hubs for dispatch and reporting, include structural facilities aligned with BFP guidelines, and provide support infrastructure like hydrants, backup water supply, apparatus bay, living quarters, support areas, and communication areas. These features will align the station with both Philippine modernization laws and global best practices, enabling efficient firefighting, rescue, and emergency response operations in the city.

CHAPTER 3

Research Methodology

This chapter outlines the research methods used to assess the feasibility and requirements for designing a centralized fire station in the City of San Jose del Monte, Bulacan. It describes the procedures employed in collecting and analyzing data from the Bureau of Fire Protection (BFP) personnel and related respondents to determine the essential facilities, spatial needs, and operational functions of a modern fire station. This chapter also discusses the research design, population and respondents, research instruments, data gathering procedures, and methods of analysis used in the study.

Research Design

This study utilized a descriptive research design with both quantitative and qualitative approaches to assess the feasibility and requirements for designing a centralized fire station in the City of San Jose del Monte, Bulacan. The descriptive method was used to obtain factual information regarding existing fire stations, operational conditions, and the needs of Bureau of Fire Protection (BFP) personnel and related responders.

Respondents with direct experience in facility management, rescue response, and firefighting operations were selected using a purposive sample technique. This sample strategy was selected due to its emphasis on people who possess the technical expertise and personal knowledge required to determine the key facilities, space needs, and operational characteristics of a centralized fire station.

The study's qualitative part comprised key informant interviews with department heads and fire station officers, while its quantitative component contained survey questionnaires given to BFP employees and those with a connection to the field. When utilized together, these techniques provide a comprehensive understanding of the design considerations and operational requirements for a modern, functional fire station.

Sample and Population

The population for this study consisted of personnel and individuals directly involved in firefighting, rescue, and emergency response operations within the City of San Jose del Monte, Bulacan. This included members of the Bureau of Fire Protection (BFP), firefighting volunteers, rescue and emergency responders, and on-the-job trainees (OJTs) assigned to various fire and rescue facilities in the city. These respondents were chosen because of their first-hand knowledge of fire station operations, facility needs, and structural limitations.

The focus of the study was on personnel assigned to existing fire stations and emergency response facilities located in Barangay Sapang Palay Proper (BFP Main

Office – CDRRMO Building), Poblacion 1 Fire Station – Daang Barangay, and Tungkong Mangga Emergency Response Facility, as these are the primary operational centers of the BFP in San Jose del Monte.

The sample included a total of 100 respondents, composed of BFP personnel, emergency responders, and trainees from the identified stations. These participants provided essential information regarding current fire station conditions, space allocation, facility adequacy, and their insights on the requirements for a proposed centralized fire station. The data gathered from this representative group served as the foundation for determining facility priorities, spatial planning, and design considerations for the proposed structure.

Sampling Method

This study used a purposive sampling method to select respondents who have direct experience and knowledge of firefighting and emergency response operations. The participants included BFP personnel, rescue responders, firefighting volunteers, and OJTs from the known fire stations and emergency facilities in San Jose del Monte City, namely the BFP Main Office in Barangay Sapang Palay Proper, Poblacion 1 Fire Station at Daang Barangay, and the Tungkong Mangga Emergency Response Facility.

They were chosen specifically because of their involvement in daily operations and familiarity with the challenges, space requirements, and facility needs of local fire stations. Their feedback will generate important data that informs the suggested

layout of a centralized fire station with the goal of enhancing workflow and efficiency.

Research Instrument

The researchers utilized a researcher-made survey questionnaire as the primary tool for data collection. It was developed to gather relevant information from Bureau of Fire Protection (BFP) personnel, rescue responders, firefighting volunteers, and on-the-job trainees (OJTs) regarding the design, functionality, and facility requirements for the proposed centralized fire station in the City of San Jose del Monte, Bulacan. The instrument aimed to assess the current status of fire stations, determine design needs, and collect recommendations to support the development of an efficient and modern centralized facility.

The questionnaire was divided into two main sets for different respondent groups. The first set was intended for BFP personnel, responders, volunteers, and OJTs and consisted of four parts. Part I focused on the assessment of the current status and challenges of fire stations through yes-or-no questions related to the adequacy of resting areas, training spaces, vehicle bays, accessibility, space allocation, and sustainable design features. Part II involved the evaluation of the centralized fire station and needed facilities, where respondents rated the importance and accessibility of proposed features such as a drone operation area, command and control center, vehicle bays, training areas, medical rooms, barracks, and communication systems using a 5-point Likert scale. Part III assessed the perception

of fire station modernization and response, allowing respondents to express their level of agreement with statements about modernization, facility efficiency, and emergency response improvement, also through a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree. Part IV provided an open-ended question that allowed respondents to share additional recommendations and suggestions for improving the proposed centralized fire station.

The second set of questionnaires was designed for Fire Marshals, Station Commanders, or Officers-in-Charge to obtain technical and operational data from station heads. It consisted of five sections. Section 1 gathered general information about the station, such as location, lot area, building type, and establishment year. Section 2 focused on personnel and staffing, collecting data on the number of staff, shift systems, accommodations, and manpower per shift. Section 3 addressed vehicles and equipment, identifying the number, type, and condition of vehicles, as well as parking or maneuvering space adequacy. Section 4 examined facility usage and space allocation, identifying existing spaces, daily users, and areas that were inadequate or lacking. Section 5 covered design considerations and future needs, emphasizing the suggested facilities, layout improvements, and structural challenges of existing fire stations.

The questionnaire combined closed-ended questions, using both yes-or-no and Likert-scale formats, with open-ended questions to collect both quantitative and qualitative data. To ensure content validity, the instrument was reviewed and

evaluated by professionals in civil engineering, fire safety, and research methodology to confirm that all items were clear, relevant, and aligned with the study's objectives.

Data Gathering

The study collected information for the design of a centralized fire station in the Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte, Bulacan, using both qualitative and quantitative methods. Interviews, site visits, and survey questionnaires were used to gather data. Information about the needs and experiences of rescue and emergency responders, firefighting volunteers, and Bureau of Fire Protection (BFP) employees was gathered through interviews. To evaluate the site's accessibility, surroundings, and suitability for the proposed project, site visits were conducted. In order to collect information about current facilities and suggestions for enhancement, surveys were also given to BFP staff, OJT trainees, firefighting volunteers, rescue and emergency responders, and engineering and safety officers. Prior to data collection, consent was obtained from the relevant offices, and all collected data was kept private and used exclusively for academic research.

Statistical Treatment

Both descriptive and qualitative statistical techniques were used to examine the data gathered from the two sets of questionnaires in order to meet the goals of the study.

The study used frequency and percentage distribution for BFP staff and associated respondents to describe the demographic features of the respondents,

including gender, field of engagement, and assignment location. The five-point Likert scale was used to calculate the weighted mean, which assessed their opinion of the significance and sufficiency of the planned facilities for the centralized fire station. This established the average degree of significance or agreement given to each indication. Descriptive equivalents from Strongly Agree to Strongly Disagree, or Very Important to Not Important, were used to analyze the results, depending on the topic.

Percentage and Frequency Distribution:

$$\mathbf{P = (\mathit{n} / \mathit{N})(100)}$$

Where:

P = Percentage

n = Frequency

N = Total Number of Respondents

For the questionnaire distributed to Fire Marshals, Station Commanders, and Officers-in-Charge, both frequency counts and weighted means were also applied to analyze data on personnel, vehicle allocation, and facility usage. Ranking was used to determine which facilities or areas were considered most needed in a modern fire station.

Weighted Mean Formula

$$\bar{x} = \Sigma\,(f \times x) / \Sigma\, f$$

Where:

f = frequency or number of respondents

x = weight or assigned rating

∑(f×x) = sum of the product of frequency and weight

∑f = total number of responses

Meanwhile, qualitative analysis was applied to open-ended responses to identify recurring suggestions, themes, and insights regarding the design, spatial needs, and operational improvements for the proposed centralized fire station.

Overall, the combined use of quantitative and qualitative analysis provided a comprehensive interpretation of the data, supporting the formulation of a functional and efficient fire station design tailored to the needs of the Bureau of Fire Protection in the City of San Jose del Monte, Bulacan.

Research Procedure

This study followed a systematic process to ensure the accuracy and reliability of the gathered data for the proposed Centralized Fire Station. The procedure began with the identification and assessment of the proposed site at Motorpool, Barangay Sapang Palay Proper, selected for its accessibility and strategic

location for centralized emergency operations. In order to collect information on operational needs, facility adequacy, and design requirements, the researchers created two sets of validated questionnaires, one for BFP employees and those working in firefighting and rescue operations, and another for Fire Marshals, Station Commanders, and Officers-in-Charge.

After approval, the identified respondents received the surveys. In order to confirm current spatial layouts and functional challenges, further data was gathered through site visits, interviews, and direct observation of existing fire stations. Descriptive statistics like frequency, percentage, and weighted mean were used to arrange, tabulate, and analyze the collected data, and thematic analysis was used to assess the open-ended responses qualitatively. The analyzed data served as the foundation for developing the architectural and structural design proposal for the centralized fire station. The analyzed data served as the foundation for developing the architectural and structural design proposal for the centralized fire station.

The design process included the preparation of floor plans, site development plans, and 3D models using AutoCAD and SketchUp. The layout and space allocation were formulated based on the data gathered from the respondents, particularly the insights and recommendations of BFP personnel and station officers regarding operational efficiency, spatial requirements, and essential facilities. The design was developed in reference to the National Building Code of the Philippines, the Fire Code of the Philippines, BFP Modernization Act of 2021 to reflect current standards and professional practices.

Geographical Locations

The chosen site in Barangay Sapang Palay Proper lies within a government-owned property near at Motorpool, Barangay Sapang Palay Proper. The area provides ample open space suitable for the construction of a centralized fire station and offers strategic accessibility to nearby barangays and major city zones. Its location allows for quick response to emergencies involving key government facilities, including the City of San Jose del Monte City Hall, public schools, hospitals, and residential communities.

The site's elevated terrain and wide road frontage make it ideal for the movement and parking of fire trucks and rescue vehicles. Its proximity to other government institutions supports inter-agency coordination during large-scale emergencies or disaster operations. Overall, the site's location in Motorpool, Barangay Sapang Palay Proper, offers an optimal balance of accessibility, safety, and operational advantage, making it suitable for the establishment of the city's centralized fire station.

Site Development Plan

The site development plan for the proposed Centralized Fire Station in Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte, Bulacan, was created using AutoCAD based on survey data and consultations with BFP personnel. Strategically located near major roads and key city facilities, the site ensures quick emergency response and accessibility. It presents the general layout of

buildings and open areas within the proposed fire station site. It includes the placement of the main structure, access roads, parking spaces, landscaped sections, driveways, and areas intended for vehicle movement. The plan also indicates the positioning of these facilities in relation to property limits, entrances, exits, and nearby roads to promote smooth traffic flow and easy accessibility.

Space Planning Diagram

The space planning diagram was conceptualized by the researchers using AutoCAD, guided by the data gathered from BFP personnel and station officers. The design focused on creating a layout that ensures efficiency, safety, and accessibility in daily operations. Spaces were organized according to their functions such as the vehicle bays, command and control center, and maintenance zone were placed near the main access points for quick deployment, while administrative offices, barracks, and support areas were positioned in quieter zones to maintain comfort and order.

The researchers also considered the flow of movement for personnel and vehicles, ensuring that circulation paths were clear and that each space served its purpose without interference. Additional provisions such as training and medical rooms were integrated to support preparedness and emergency response. This layout reflects the researchers' goal of creating a practical, well-organized, and emergency-ready facility that addresses both the operational and welfare needs of BFP personnel.

Floor Plans and Structural Designs

This section presents the floor plans and structural design considerations for the proposed Centralized Fire Station. As essential components of any civil engineering project, detailed plans ensure accuracy, coordination, and clarity throughout the design process. The researchers developed detailed 2D architectural drawings using AutoCAD, illustrating the layout of key spaces. The structural plans were designed to ensure stability, structural integrity, and proper space distribution to support the operational and functional requirements of the Bureau of Fire Protection in the City of San Jose del Monte, Bulacan.

Plumbing Layout Plan

This section presents the plumbing layout for the proposed Centralized Fire Station. Developed using AutoCAD, it illustrates the water supply, drainage, and sanitary systems designed to ensure efficient water flow for firefighting, daily use, and emergency needs. The layout promotes functionality, safety, and compliance with standard plumbing requirements.

Electrical Layout Plan

This section presents the electrical layout for the proposed Centralized Fire Station. Designed using AutoCAD, it shows the placement of lighting, power outlets, and main electrical lines to ensure efficient energy distribution and

operational safety. The layout supports the continuous operation of essential facilities while complying with electrical standards and safety codes.

3D Design Model

The 3D design of the proposed Centralized Fire Station was created using SketchUp, reflecting the analyzed data and feedback from BFP personnel and station commanders. The model illustrates the conceptual layout of key spaces such as vehicle bays, command and control center, barracks, training, and medical areas. Each element was designed to enhance functionality, accessibility, and operational efficiency. The 3D visualization provides a clear and realistic representation of how the proposed fire station will look like as a modern facility ready for rapid emergency response.

Respondents: BFP Personnel / Personnel Related to Firefighting And Rescue

This questionnaire is part of a study by BS Civil Engineering students of La Concepcion College titled **"DESIGN OF A CENTRALIZED FIRE STATION FOR EFFICIENT FIREFIGHTING OPERATIONS, RESCUE, AND EMERGENCY RESPONSE AT MOTORPOOL, BARANGAY SAPANG PALAY PROPER, CITY OF SAN JOSE DEL MONTE, BULACAN."** It aims to gather insights from BFP personnel and responders to identify the essential facilities and design features required for a modern, efficient centralized fire station. This survey complies with **Republic Act No. 10173**, the **Data Privacy Act of 2012**. All information gathered will be kept **confidential** and used **only for academic and research purposes.**

NAME
(Optional):_____

(Please check ✓ the appropriate box)

Gender:
☐ Male ☐ Female ☐ Prefer not to say

Field of Involvement:
☐ Bureau of Fire Protection (BFP) Personnel
☐ Firefighting Volunteer
☐ Rescue or Emergency Responder
☐ OJT (On-the-Job Trainee) in the Fire or Rescue Field
☐ Related Profession (Engineering, Safety, or Emergency Services)
☐ Others: _____

Place of Assignment or Training:
☐ BFP Main Office – CDRRMO Building, Brgy. Sapang Palay Proper
☐ Poblacion 1 Fire Station – Daang Barangay
☐ Tungkong Mangga Emergency Response Facility
☐ Muzon Emergency Response Facility
☐ Other Area: _____

Type of Emergencies Most Frequently Responded To:

☐ Structural Fires ☐ Vehicular Accidents ☐ Medical Emergencies ☐ Rescue Operations ☐ Natural Disasters ☐ Others: _____

Part I: Assessment of Current Status and Challenges of Fire Stations

Please check (✓) one box for each question.

1. Does your fire station have adequate resting and sleeping quarters for personnel on duty?
   ☐ Yes ☐ No

2. Does your fire station have a designated training or briefing area?
   ☐ Yes ☐ No

3. Is your station layout designed to support fast response and deployment?
   ☐ Yes ☐ No

4. Is your fire station easily accessible to major roads and residential areas?
   ☐ Yes ☐ No

5. Does the current space allocation (for vehicles, storage, and rest areas) meet operational needs?
   ☐ Yes ☐ No

6. Does your station have sufficient vehicle bays for all trucks and units?
   ☐ Yes ☐ No

7. Are the living quarters and day-to-day facilities (kitchen, recreation, restrooms) in good condition and adequate for on-call personnel?
   ☐ Yes ☐ No

8. Does your station include a space dedicated to community engagement or fire-prevention education (e.g., for school visits or drills)?
   ☐ Yes ☐ No

9. Has the station taken steps to incorporate sustainable design features or resilient infrastructure (e.g., backup power, energy efficiency, weather protection)?
   ☐ Yes ☐ No

10. Do you believe the station's current facility condition allows fire personnel to operate safely and comfortably at all times?
    ☐ Yes ☐ No

Part II: Evaluation of Centralized Fire Station and Needed Facilities

Matrix Rating Question

Please rate your opinion on the importance and accessibility of fire response, as well as the necessity of facilities in designing a centralized fire station for the Bureau of Fire Protection (BFP) in San Jose del Monte City.

Place a check (✓) in the box that represents your answer based on the rating scale below:

Rating Scale	Meaning
5	Very Important / Very Accessible
4	Important / Accessible
3	Moderately Important / Hard to Reach
2	Slightly Important
1	Not Important / Not Accessible

	1	2	3	4	5
Importance of establishing a centralized fire station in the city					
Accessibility of fire response in your area					
Drone operation and monitoring area					
Modern vehicle bays for fire trucks and rescue units					
Command and control center with advanced communication systems					
Communication and information technology systems					
Fire poles for quick firefighter movement between floors					
Training and simulation facilities					
Medical and rescue support rooms					
Barracks and living quarters for firefighters and rescuers					

Part III: Perception on Fire Station Modernization and Response

Please check (✓) the box that represents your answer based on the rating scale below.

Rating Scale:
5 – Strongly Agree 4 – Agree 3 – Neutral 2 – Disagree 1 – Strongly Disagree

	1	2	3	4	5
A centralized fire station can reduce emergency response time in the city.					
Properly designed vehicle bays ensure faster deployment during emergencies.					
A well-designed vehicle bay improves operational efficiency and extends the service life of fire trucks by providing proper weather protection and maintenance space.					
A command and control center enhances coordination and communication during operations.					
Medical and rescue rooms are essential for providing first aid and emergency treatment.					
Training and simulation areas strengthen firefighter preparedness and skills.					
Barracks and living quarters help maintain 24/7 readiness of fire personnel.					
Public/community engagement space (e.g., for fire-prevention education, school visits, and community drills) within the fire station enhances overall safety and community trust.					
A dedicated decontamination zone (for personnel and equipment returning from incidents) is essential for protecting fire station living and working spaces.					
Sustainable design features (e.g., solar panels, energy-efficient systems, resilient backup power) in the fire station facility are essential for ensuring uninterrupted operations during significant events.					

Part IV: Open-Ended Question

1. What other facilities or improvements would you recommend for the proposed centralized fire station in San Jose del Monte?

   _____

   _____

   _____

Respondent: Fire Marshal / Station Commander / Officer-in-Charge

This questionnaire is part of a research study by BS Civil Engineering students of La Concepcion College entitled "Design of a Centralized Fire Station for Efficient Firefighting Operations, Rescue, and Emergency Response at Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte, Bulacan." It seeks to gather technical and operational information from station officers to support the design of a centralized fire station that enhances functionality, space utilization, and emergency response efficiency. This survey complies with **Republic Act No. 10173**, the **Data Privacy Act of 2012**. All information gathered will be kept **confidential** and used **only for academic and research purposes.**

Section 1: General Information

1. **Name of Respondent:** _____
2. **Position/Designation:** _____
3. **Name of Fire Station:** _____
4. **Location/Address:** _____
5. **Lot Area (approximate):** _____ sq. m.
6. **Building Type:** ☐ One-storey ☐ Two-storey ☐ Multi-storey

Section 2: Personnel and Staffing

1. How many **total personnel** are assigned to this station? _____
2. How many **fire officers** (uniformed) are currently active? _____
3. How many **administrative/non-uniformed staff** are assigned? _____

4. How many **volunteers or OJTs** regularly assist the station? _____

5. What is the **average number of personnel per shift?** _____

6. What is the **shift system** followed?
   ☐ 24 hours on duty / 48 hours off ☐ 12-hour rotation ☐ Others: _____

7. Do personnel stay overnight on-site? ☐ Yes ☐ No

8. If yes, how many **sleeping quarters or barracks spaces** are currently provided? _____

Section 3: Vehicles and Equipment

1. How many **fire trucks** are currently operational? _____

2. What are the **types of fire trucks** available? (e.g., pumper, tanker, aerial ladder, rescue)

   _____

3. How many **rescue or support vehicles** are in service? _____

4. Where are the vehicles currently parked or stored?
   ☐ Covered garage ☐ Open area ☐ Shared space ☐ Others: _____

5. Do you encounter **space constraints** for vehicle movement or parking? ☐ Yes ☐ No
   If yes, please describe: _____

6. What is the **average number of vehicle deployments per day/week?** _____

Section 4: Facility Usage and Space Allocation

1. Approximately how many people **use the station daily** (including personnel, visitors, and trainees)? _____

2. Which areas are currently **lacking or inadequate**? (Please specify)

   _____

Section 5: Design Considerations and Future Needs

1. What facilities should a **modern centralized fire station** include to improve operations?

   _____
   _____

2. What are the **biggest challenges** in your current station's structure or facilities?

   _____
   _____

3. If given a chance to redesign the station, what **spatial improvements or layout features** would you suggest?

   _____
   _____

4. Any additional comments or recommendations for future fire station design?

   _____
   _____

CERTIFICATE OF QUESTIONNAIRE VALIDATION

This certifies that the questionnaires on our study entitled,

"DESIGN OF A CENTRALIZED FIRE STATION FOR EFFICIENT FIREFIGHTING OPERATIONS, RESCUE, AND EMERGENCY RESPONSE AT MOTORPOOL, BARANGAY SAPANG PALAY PROPER, CITY OF SAN JOSE DEL MONTE, BULACAN"

Originally owned by group E3 from BSCE-4E, Guian Abigail DP. Santos, Rheyven B. Juan, John Marwin D. Taganna, and Sophia Banico have been assessed and validated on the 27th of October 2025.

The questionnaire was carefully examined to determine whether each item appropriately measures the data required to assess facility needs, spatial distribution, and structural design considerations for the proposed centralized fire station. After extensive evaluation, the validators confirmed that the instrument is valid, appropriate, and ready for data collection.

Validated by:

10/25/25

Engr. Jore Gil D. Galeza, Ph.D., MEM, SO2
Civil Engineering Professional
(Signature over Printed Name)

Engr. Eloisa P. Cadag, CE, MACT
Civil Engineering Professional
(Signature over Printed Name)

Engr. Russell R. Llagas
Civil Engineering Professional
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Certified True and Correct:

Engr. Eloisa P. Cadag, CE, MACT
Research Adviser
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